Factors Associated with Xylene Exposure

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Abstract— *Xylene is an ingredient that is most dominant in spray painting in the automotive industry. When the paint is sprayed, the worker will be exposed not only by the vapor, but also from the mist, a collection of fine particles in the form of a liquid. This study was conducted in one area of car painting in Surabaya. The aim of this study is to analyze factors associated with xylene exposrue. Car painter is a group of workers at risk for exposure to xylene. In addition, workers also do not know the dangers of exposure to xylene against him. This study was designed as an observational study conducted cross-sectional to analyze the relationship between levels of xylene exposure and characteristic of workshops in car painting area in Surabaya. Result of Spearman test for analyzing factors associated with xylene exposure showed a significant correlation on temperature and humidity. Based on the independent-samples t-test it can be concluded that there is a statistically significant difference between two conditions, if the cut off point of this comparison based on TLV, 100 ppm. As the conclusion, there is a relationship between characteristics of workshops with xylene exposure in car painting areas in Surabaya.*

Keywords— xylene levels, exposure, car painter.

I. INTRODUCTION

Growth in the number of people around the world so rapidly have encouraged the era of industrialization. A period marked by the rapid development of science and technology, so that people can more easily meet their needs. The situation is further open employment diversity. The field work is needed on the one hand, but on the other hand need realize the problems that need to be considered which is associated with the impact of occupational diseases.

The growing world of industry led to a growing number of potential dangers and risks faced by workers. Potential hazards and risks in the industry for example, a variety of chemicals that are raw materials, by-products, as well as a variety of factors other hazards that may pose a risk to the workforce.

Indirect impact on the progress of industrialization in the form of occupational disease, where this needs serious attention. One area of work that needs attention is occupational disease in workers exposed to organic solvents for example on paint manufacturing workers, shipyard workers in the painting, car repair shop, and etc.

A variety of health consequences, including the risk of occupational diseasebecause of exposure to chemicals contained in the organic solvents, one of which is a neurological complaints.

The workers groups need attention because their numbers are constantly growing, while the risk of disease due to its big enough. Currently no less than 100 car paint repair shop car painting spread over the area in the Village Bubutan, District Bubutan, City Surabya. That number has increased gradually each year.

Car painting process using paints containing organic solvents. Exposure to paint solvent vapor can cause irritation and damage to the eyes and mucous membranes, respiratory and gastrointestinal tract, and skin. Exposure to organic chemicals (xylene, n-hexane, methylalcohol etc.) can cause damage to the nervous system.

II. METHODS

This study was designed as an observational study conducted cross-sectional to analyze the relationship between levels of xylene exposure and characteristic of workshops in car painting area in Surabaya. The study involved five workshops of car painting which consist of car painters worked in.

In this study the variables that will be carefully divided as the characteristics of workshops such as, length of work, part of the job, years of smoking habit, the habit of exercise, use of protective equipment themselves in the form of masks, and xylene levels in environmental work station in car painting areas in Surabaya.

The technique of collecting data using interview techniques with the help of questionnaires, observations with the help of a checklist, and documentation study.

III. RESULT AND DISCUSSION

Surabaya is the capital of East Java province. Geographically located between the 0721 'South latitude and 11236' - 11 254 'east longitude. Metropolis with a population of nearly 3 million inhabitants. The total area of 274.06 km2 Surabaya city is divided into 31 districts and 163 villages / wards.

Bubutan sub-district is one of the districts of the 31 districts in Surabaya with the area of 4.04 km². There are five villages in the district Bubutan, namely Bubutan Village, Village Alon-Alon Contong, Gundih Village, Village Jepara, and Wall Dukuh village. This study was conducted in Pengenal Street, Village Bubutan.

The majority of residents in Pengenal Street work as informal workers who work in the welding shop, dodog and car paint. Painting businesses have been around since the 1970s, located in Pengenal Street and surrounding areas. This effort is the informal sector, where the painting operations carried out at the roadside, with the type of business that is almost the same, namely to serve the painting, dodog and welding. Type of vehicle is a car serviced in general, but some workshops also receive a motor painting services.

Car painting business premises located on the roadside, or utilize unused land, such as the National House lawn Indonesia, Printing Birawa building parking lot, and several permanent workshop in Jalan Identity, District Bubutan, Surabaya. Garage business at this location consists of workshops open and semi-enclosed garage (partially open). In general, the final stage of car painting is done in the open field, semi-enclosed workshop is usually used to paint a small section of the car.

At the beginning of the development of painting in the street identifier Surabaya car starts from a few people who open businesses car painting, then increasing over time, the increasing needs and limited formal employment, many people involved in car painting open businesses in the area.

Most workers in Jalan identifiers are migrants from outside the region Surabaya. Car painting effort started on average at 08.00 to 17.00 every day of the week. However, there are several workshops which only operates Monday to Saturday. The study involved 51 workers car painting which is divided into 36 painters and 15 pendempul.

Based on observations during the study, materials used in vehicle paint is organic solvent and paint. Painting is done by spraying (spray paint) with the help of the compressor. Material that comes out in the form of aerosols containing some chemicals. One of the chemicals found in paint solvent is xylene.

Organic solvents are widely used in industry, among others in the processing of fuels, degreasant, adhesive and paint industry. It is estimated that about 2 million workers (9% of the working population) in the United Kingdom using these chemicals on a regular basis (Dick et al., 2000). In Indonesia, the use of organic solvents widely used, especially in the industrial sector which uses chemical raw materials, one of them in the painting industry.

Xylene is an ingredient that is most dominant in spray painting in the automotive industry (Winder and Stacey, 2005). When the paint is sprayed, the worker will be exposed not only by the steam, but also from the mist, a collection of fine particles in the form of a liquid. The shape will be very easily inhaled by workers or into the skin, especially if not wearing a mask and appropriate work clothes (WWAC 2009).

Levels of xylene composition measured by a laboratory, which is m-xylene (40-65%), p-xylene (20%), o-xylene (20%) and ethyl benzene (6-20%). Occupational Safety and Health Administration (OSHA) set a limit value of tolerance or permissible exposure limit (PEL) is 100 ppm for xylene in a concentration of 8 hours of exposure or 8-h time-weighted average (TWA). National Institute for Occupational Safety and Health (NIOSH) recommended exposure limits xylene is 100 ppm TWA up to 10 hours on working hours per day or 40 hours per week and 200 ppm for 10 minutes of exposure as brief exposure or short-term limit (Kandyala, 2010) ,

Some studies show the health hazards due to exposure to xylene, the acute exposure of 200-ppm for 3-5 minutes cause iriasi the eyes, nose and throat (Malathi, 2014). Symptoms of anorexia, nausea and vomiting shown by workers exposed to vapors of xylene for 2 weeks (Uchida et al., 1993). Exposure to 10,000 ppm of xylene in inhalasai show complaints of kidney function characterized by increased levels of β-glukoronidase and albumin in the urine, as well as the excretion of red blood cells and white blood cells in the urine (Malathi, 2014). A study conducted on some groups of workers in Turkey. Increased damage to the auditory group paint manufacturing industry workers and workers painting in Turkey showed 131 workers exposed to organic solvents and noise of 85 dB in the workplace is higher than that of workers exposed to noise only at the same rate. Organic solvents used as raw materials in this group are xylene.

Based on this research showed levels of xylene in work environment area in Surabaya among five locations that manage the car painting business, (see **Table 1**) respectively 31.70 ppm, 60.68 ppm, 65.93 ppm, 271 ppm and 341 ppm, with levels of xylene in the air two workshops are known to exceed the threshold limit value (TLV), which is 100 ppm. However, type of workshops thought to affect level of xylene exposure. As the airway or ventilation have a big role with the path of xylene exposure.

The initial three workshops (A,B and C) apparently shows the lower levels of xylene then last workshops (D and E) as they are kind of open workshops, while D and E are partially open workshop with no local exhaust. This research was conducted in car painting area informally. In general, there are two types of painting locations, namely

the location of open and semi-closed. to an open location, the painting done in the field or outdoors. However, in the semi-enclosed locations, performed in a workshop that had the door open, but does not have good air exchange system.

According to NIOSH (2005), TLV-STEL for xylene is 50-100 ppm. The health risk resulting from xylene exposure in car painting areas were calculated from various workshop throughout study located. The exposure data was collated based on the workshop. Health risk was evaluated for each scenario using the concentration exposure levels (C) in **Table 2.** In this study, it is known that the greater levels of xylene in the air, then the exposure concentration that is projected to be greater. based on Table 1, if the levels of xylene in the air received by the engine gauges indicate safe levels of 65.39, the duration for workers can work at the site is estimated to a maximum of 4 years at the latest. Therefore, the greater the exposure, the recommended safe duration getting shorter. Based on the analysis of risk exposure to xylene, known RfC of xylene is 0,001 mg / kg.hari, then by exposure to 65.93 ppm, xylene toxic effects can be found in workers with a weight of 70 kg and a working 300 days per year with a duration of safely xylene in the body for 4 years.

On the other hand, temperature of five workshops considered in same trends which are in a rate of 30^{o}C to 34 ^{o}C. if it links to the exposure, concentration of xylene more than 100 ppm tended to rise in high temperature. Some argue if volatile organic compound with its characteristic as vapor can highly evaporate then been compiled as the molecules weight of xylene itself. The majority of xylene released to the environment directly into the atmosphere. In the atmosphere, xylene isomers are readily degraded, mainly by photo oxidation. Volatilization into the atmosphere from the water quickly for all three isomers of xylene. We can see in **Figure 1,** where the highest concentration of xylene in the workshop E showing highest temperature as well. Otherwise, in the lower of concentration of xylene there were also the lower of temperature.

In contrast, humidity in location C was the highest among five workshops over the location. Even though this location barely same with initial workshops as open workshops, the exposure highlighted as below the threshold limit value (TLV). The influence of humidity on the decomposition of VOCs has been studied for several VOCs. Water vapor could enhance the removal efficiency since it may evolve into hydroxyl radical, whose oxidation power is superior to other oxidants.

Another point to consider is the number of worker in each workshop. It deals with average of costumer that they serve every day. Basically, car painting spend around 3 to 7 days to last step, which is polishing. Based on the location of the workshop known distribution of the number of workers in the car painting in Surabaya as follows in **Table 1.** Bar chart describes the distribution of the number of workers in the car painting in Surabaya, the largest known number of workers are in Workshop C, which is 13 people or 25.5%, while the lowest was in Workshop B, as many as 8 or 15, 7%. In general, all workshops experience the same patterns either for number of workers and costumer in a week to some extent, but percentage of workers in workshop C, which have more workers, also have sizeable number of costumer. However, type of workshop in C is the same with A and B which are open workshop, while workshop D and E are kind of partially open workshop.

Based on this study also reported the, working periode and working duration of respondents, known to the average service life of 22.29 years, while the average length of employment of the respondents is 7.29 hours. The minimum employment period of workers is 9 years old and the longest working period is 41 years. In addition, long known that the worker is a minimum of 5 hours per day, and a maximum working time of 8 hours per day.

Results of research on the frequency distribution in car painting areas (**Table 1)**, it is known from the 51 respondents who works as a painter as many as 36 people or 70.6%, while 15 people as non-painter os technical staff as 29.4%.

IV. FIGURES AND TABLES

Table 1. Levels of xylene in work environment area

Location	Xylene concentration (ppm)	Number of workers	Type
A	31.70	11	Open
B	60.68	8	Open
C	65.93	13	Open
D	271.00	10	Partially open
E	341.00	9	Partially open

Table illustrating checklist of information for xylene exposure.

Table 2. Projected of xylene exposure based on health risk assessment.

Location.	Xylene Conct. (ppm)	Conct. Exposure Level (C) (mg/m^3)	Safety duration (years)
A	31.70	134.48	8.15
B	60.68	257.42	4.03
C	65.93	279.70	4.05
D	271.00	1149.66	0.92
E	341.00	1446.63	0.80

Table illustrating xylene exposure based on health risk assesment. The higher the concentration of xylene, the higher the concentration of exposure to human and the fastest of safety duration.

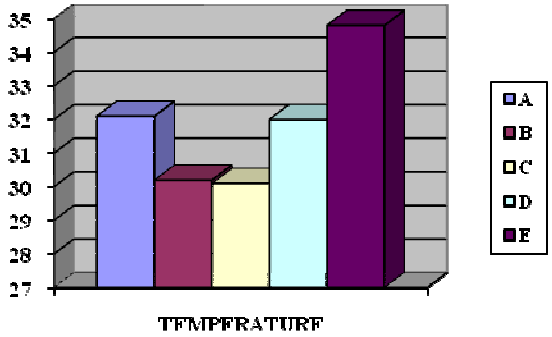

Fig. 1: Frequency distribution based on temperature over the location of car painting in Surabaya.

V. CONCLUSION

Based on the analysis of factors associated with xylene exposure, it can be concluded as follows:

1. There is a relationship between characteristics of workshops with xylene exposure in car painting areas in Surabaya.
2. Factors workshop characteristics form and pettern of working is associated with increasing levels of xylene exposure in car painting workshop in Surabaya.

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